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FINDINGS OF SEISMOACOUSTIC INVESTIGATIONS OF THE STRUCTURE OF THE PACIFIC OCEAN BOTTOM SOUTHEAST OF THE ISLAND OF HOKKAIDO

- USSR -

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FINDINGS OF SEISMOACOUSTIC INVESTIGATIONS OF THE STRUCTURE OF THE PACIFIC OCEAN BOTTOM SOUTHEAST OF THE ISLAND OF HOKKAIDO

(Presented by academician D. I. Shcherbakov on 14 July 1959.)

Investigations of the structure of the bottom of seas and the ocean by seismoacoustic methods have been carried out for a number of years by the Institute of Oceanology of the Academy of Sciences USSR. On the 28th voyage of the "Vityaz'" such investigations were carried out in the northwestern part of the Pacific Ocean, in an area approximately 700 km southeast of the island of Hokkaido. The choice of an area for the investigations was determined by the desire to obtain information on the depths of the sedimentary cover, and of the most important layers of the earth's crust characterizing the outer structure of the ocean bed -- a swell extending in a northeasterly direction along the Kurile-Kamchatka trough. Investigations were carried out on three profiles oriented across the course of the swell: profile I (northern), situated on the vaulted part of the swell (ocean depth 5,180-5,550 m); II (central), situated on its southeastern wall (ocean depth 5,600-5,750 m); III (southern), situated on the surface of the bottom of the northwestern syncline of the Pacific Ocean (ocean depth 5,650-5,810 m). The length of profile I is 110 km; that of II and III, 70 km each.

Investigations were carried out by the method of a shifting explosion point with the reception and recording of direct, reflected, and refracted waves. The distances between the explosion point and the reception point were determined by the time of the passage of a direct water wave, or from the correlation of the time lags of the reflected waves of a different multiplicity factor in those cases when a direct water wave could not be received. The recording of signals was carried out with the aid of two identical receiver-amplifier channels with three amplification channels distinguished by the band of frequencies being transmitted (3-8; 5-35; 100-1,200 cycles). The explosions were carried out at an interval of 1.5 miles on the 12 miles of profile nearest to the point of reception, and then every 3 miles. Each profile was explored twice in opposite directions. Thus the technique of the explorations basically corresponded to that used by the Institute of Oceanology in work in other areas (1, 4-6), and was also similar to the technique used by foreign researchers (7-9).

In processing the materials obtained, various methods of analyzing the reflected waves (the method of the squares of the times of lags, the method of critical angles, the method of universal curves) were used, as well as the methods of analyzing refracted waves customary in terrestial seismic explorations. The construction of boundary limits was done by the fields of time method (2).

Results of the analysis show the following. On all three profiles the surface of the bottom is underlain by a stratum characterized by the speed of propagation of resilient oscillations from 1.6 to 2.0 km/sec, with an evident increase in speed in the direction of the base of the stratum. This stratum is considered as a layer of porous sedimentary deposits which thickens towards the base of the layer. Low-frequency components of signals reflected from the surface underlying the sedimentations appear on all profiles at least twice as intensive as the reflections from the surface of the bottom. This phenomenon was noted earlier during the work of the 19th voyage of the "Vityaz'" (3). On all three profiles a group of refracted waves characterized by a boundary speed of 6.5 km/sec was tracked. Waves with such a speed were taken to establish the upper boundary surface of the so-called basalt layer. On profile I (northern) waves were tracked with a boundary speed of about 9.0 km/sec. Waves with such a boundary speed were isolated with a small degree of certainty on the profile adjacent to the south but were not isolated on the southern one. As is known, the lower boundary of the basalt layer and, at the same time, the lower boundary of the earth's crust, usually called the Mokhorovichich division, in the Pacific Ocean is characterized in most cases by a boundary speed of about 8.3 km/sec (11). This explains the great magnitude of boundary speed obtained on the 28th voyage of the "Vityaz'", but whether it is therefore possible to identify it with the Mokhorovichich division is not yet clear. Besides these groups of waves on the south end of profile II and on the north end of profile III, a group of waves was traced with a boundary speed of 5.3 km/sec. Waves with such a speed may be identified, as it appears to us, with a volcanic stratum just as was done for the results obtained in the area of the Tonga trench (10).

The thickness of the sedimentary stratum varied considerably. It is equal to 510 m at the northern end of profile I, decreases to 280 m on its south end, and equals 340 m on the northern end of profile II. A sharp reduction in the thickness of the sedimentary stratum up to 100 m is observed at the junction point of the south end of profile II and the north end of profile III. At the southern end of profile III the thickness of the sedimentary stratum increases to 560 m. The thickness of the basalt layer, which was determined only for profile I, amounts to 7 km.; the thickness of the volcanic stratum at the junction of profiles II and III is about 1 km.

The profiles investigated are located in the area of the ocean bed: therefore the data obtained on the slight thickness of the sedimentary layer, on the thickness of the basalt layer, and the existance of a volcanic substance above the basalt layer, it seems to us, are in keeping with the findings of other researches (6, 11). The distribution of the thicknesses of the sedimentary layer is peculiar. Nearer to the anticline part of the swell, the thickness of the sediments appears greater than in the region of the southeastern wall. It is interesting to note that a similar correlation between the thicknesses of the sedimentary stratum and the morphology of the outer swell was detected by K. B. Bakar

(Acoustics Institute of the Academy of Sciences USSR) during the analysis of the materials of seismoacoustic investigations on the 19th voyage of the "Vityaz'" for the region southeast of Kamchatka. How can such a dislocation of the minimum thicknesses of the sedimentary stratum relative to the morphologic axis of the swell be explained, when one could expect the minimum thicknesses on the axis of the swell? Possibly this could be explained by the timely dislocation of the morphologic axis of the swell in the direction of the Kurile-Kamchatka trough, in connection with the development of the Kurile-Kamchatka geosyncline zone.

The investigations of the 28th voyage of the "Vityaz'" were not so excessively detailed, so that it was possible to compare the variations observed in the thicknesses of the sedimentary stratum with the irregularities of the surface of the bottom of relatively small scales. It can be assumed that sharp variations in the thickness of the sedimentary stratum are connected with irregularities of the primary relief, and that the small forms of the bottom relief here reflect the character of the primary relief of the surface of basalt and of volcanic formations. For example, the above-mentioned volcanic body at the junction of profiles II and III is apparent in the bottom relief as an upheaval, although it is covered with a sedimentary stratum. It is possible that the underwater mountain between profiles I and II is a volcanic cone breaking through the sedimentary stratum. The fact that this mountain and the volcanic body belong to the southeastern wall of the swell is apparently regular, inasmuch as the wall of the swell must be examined as an area of extension.

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FIGURE CAPTIONS

Figure 1. Position of profiles I, II, and III for the seismoacoustic sounding of the 28th voyage of the "Vityaz'".

Figure 2. Structure of the earth's crust according to data of the seismoacoustic sounding of the 28th voyage of the "Vityaz'." Numbers designate the speed of sound in the layer in km/sec.

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